CLAIMS

What is claimed is:

1. (currently amended)A method of determining a parameter of interest for a region of an earth formation using a nuclear magnetic resonance (NMR) instrument conveyed in a borehole, the method comprising:

(a) producing a static magnetic field in ~~a region including~~ said region ~~of interest~~;

(b) transmitting a sequence of radio frequency (RF) pulses ~~for~~ and producing an RF magnetic field in said region, said RF magnetic field having a spatially varying intensity in said region ~~and a direction substantially orthogonal to a direction of said static magnetic field, a subset~~ at least one of said RF pulses ~~further~~ having a pulse length related to ~~zeros~~ a zero of a Bessel function;

(c) receiving NMR signals ~~having amplitudes~~ produced by said RF magnetic field; and

(d) determining said parameter of interest using said ~~amplitudes~~ received NMR signals.

2. (currently amended)The method of claim 1 wherein said said parameter of interest comprises at least one of (i) a spin density function, (ii) porosity, (iii) fluid content, (iv) permeability, (v) longitudinal relaxation time, and, (vi) transverse

relaxation time .

3. (currently amended)The method of claim 1 wherein said NMR signals comprise free induction decay signals ~~associated with said subset of RF pulses~~.

4. (currently amended)The method of claim 1 wherein said ~~subset of~~ sequence of RF pulses comprises tipping pulses~~, the pulse sequence further comprising a plurality of~~ and refocusing pulses ~~associated with said tipping pulses~~, and wherein said NMR signals comprise spin echo signals.

5. (currently amended)The method of claim 3 wherein determining said parameter of interest further comprises performing an inverse Hankel transform on said NMR signals.

6. (currently amended)The method of claim 5 wherein determining said parameter of interest further comprises using a spatial mapping to map ~~said~~ a spin density to a spatial location.

7. (currently amended)The method of claim 4 wherein said ~~sequences~~ sequence of RF pulses ~~are~~ is of the form:

$$[\tau_j - \frac{TE}{2} - (R - TE)_i - TW]_j$$

where TE is a time interval between refocusing pulses R, τ_j is a tipping pulse, TW is a wait time, i is the index of the number of refocusing pulses, and j is the index of the number of CPMG (or modified CPMG) sequence acquired for a single tipping pulse.

8. (original)The method of claim 7 wherein determining said parameter of interest further comprises summing the spin echo signals resulting from said sequence of RF pulses over the index j for a selected value of i.

9. (original) The method of claim 8 wherein said summing is a weighted summing.

10. (currently amended) The method of claim 9 wherein determining said parameter of interest further comprises using a spatial mapping to map ~~said~~ a spin density to a spatial location.

11. (currently amended) The method of claim 6 further comprising determining spins associated with a portion of the region ~~of interest~~ outside said borehole.

12. (original)The method of claim 10 further comprising determining spins associated with a portion of the region outside said borehole.

13. (currently amended)The method of claim 6 further comprising partitioning ~~said~~ spins into azimuthal sectors.

14. (currently amended)The method of claim 10 further comprising partitioning ~~said~~ spins into azimuthal sectors.

15. (original)The method of claim 1 further comprising repeating (a) – (d) for a number of different azimuthal orientations of said instrument.

16. (currently amended)The method of claim 15 further conveying said NMR instrument into said borehole on a bottom hole assembly.

17. (currently amended)An apparatus for determining a parameter of interest ~~for~~ of a region of an earth formation comprising:

(a) a magnet ~~for~~ producing a static magnetic field ~~having a direction~~ within the region;

(b) a transmitter ~~for~~ transmitting a sequence of radio frequency (RF) pulses ~~for~~ and generating a RF magnetic field in said region, said RF magnetic field having a spatially-varying intensity in said region ~~and a direction substantially orthogonal to the direction of the static magnetic field~~,

(c) a processor ~~for~~ controlling said transmitter and defining ~~a subset~~ at least

one of said RF pulses to have a pulse ~~lengths~~ length related to ~~zeros~~ a zero of a Bessel function;

(d) a receiver ~~for~~ receiving NMR signals produced by said RF magnetic field; and

(e) a processor ~~for~~ determining said parameter of interest from ~~amplitudes of~~ said NMR signals.

18. (currently amended)The apparatus of claim 17 wherein said said parameter of interest comprises at least one of (i) a spin density function, (ii) porosity, (iii) fluid content, (iv) permeability, (v) longitudinal relaxation time, and, (vi) transverse relaxation time .

19. (currently amended) The apparatus of claim 17 wherein said NMR signals comprise free induction decay signals ~~associated with said subset of RF pulses~~.

20. (currently amended)The apparatus of claim 17 wherein sequence of ~~pulses of said subset of~~ RF pulses ~~are~~ comprise tipping pulses~~, the pulse sequence further comprising a plurality of~~ and refocusing pulses ~~associated said tipping pulses~~ and wherein said NMR signals comprise spin echo signals.

21. (original) The apparatus of claim 17 wherein said processor in (e) is configured so as

to determine a spin density as a function of said RF field intensity.

22. (original) The apparatus of claim 21 wherein said processor is configured to transform said spin density to a spatial location.

23. (currently amended) The apparatus of claim 21 wherein said ~~sequences~~ sequence of RF pulses ~~are~~ is of the form:

$$[\tau_j - \frac{TE}{2} - (R - TE)_i - TW]_j$$

where TE is a time interval between refocusing pulses R, τ_j is a tipping pulse, TW is a wait time, i is the index of the number of refocusing pulses and j is the index of the number of CPMG (or modified CPMG) sequence acquired for a single tipping pulse.

24. (currently amended) The apparatus of claim 17 wherein the same antenna is used for transmitting said RF pulses and receiving said NMR signals.

25. (original)The apparatus of claim 17 wherein said processor in (c) and said processor in (e) are the same.

26. (new) The method of claim 1 wherein said Bessel function is a Bessel function of zero order and first kind.

27. (new) The apparatus of claim 17 wherein said Bessel function is a Bessel function of zero order and first kind.

28. (new) A method of composing a radio frequency (RF) pulse sequence for use in a nuclear magnetic resonance (NMR) apparatus, the method comprising:

(a) defining a length of at least one pulse of the RF pulse sequence based on a zero of a Bessel function;

(b) producing a RF field with said RF pulse sequence; and

(c) analyzing NMR signals resulting from the produced RF field.

29. (new) The method of claim 28 wherein said Bessel function is a zero order Bessel function of the first kind.

30. (new) A nuclear magnetic resonance (NMR) apparatus comprising:

(a) a processor that:

(i) defines a length of at least one pulse of a radio frequency RF pulse sequence based on a zero of a Bessel function, and

(ii) pulses a transmitter with the RF pulse sequence,

wherein the transmitter produces a RF field;

(b) a receiver which receivers NMR signals resulting from the RF field;

(c) a processor which analyzes the received NMR signals.

31. (new) The NMR apparatus of claim 30 wherein the Bessel function is a Bessel function of zero order and the first kind.